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Engineering

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OFFICIAL PROCEEDINGS

Meeting of November, 1920

Volume XIX.
No. - - - 8

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CONTENTS

REPORT OF NOVEMBER MEETING

also

PAPER AND DISCUSSION

on

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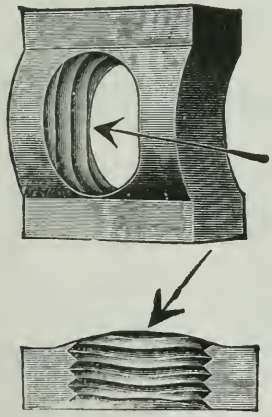

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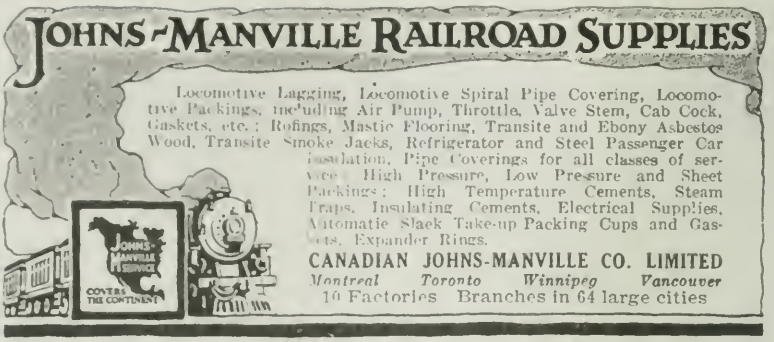
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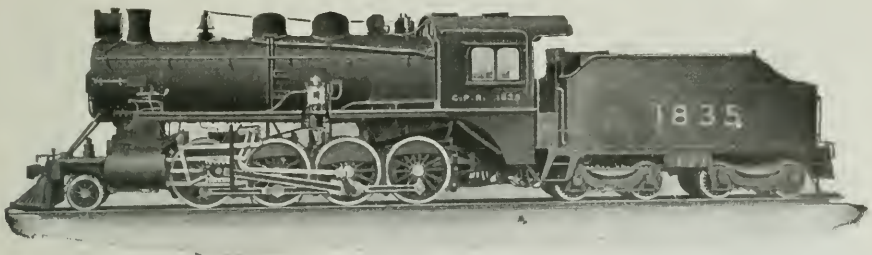

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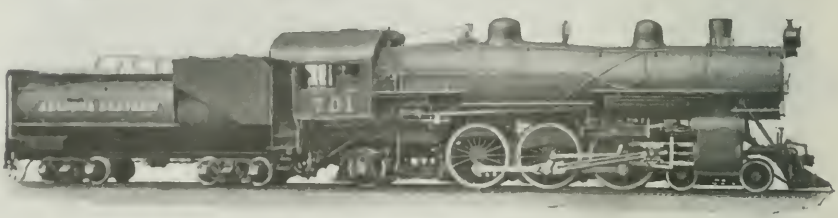

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Vol. XIX. No. 8 **Montreal, Can., Nov. 9, 1920** 25c. per copy

PROCEEDINGS OF THE CANADIAN RAILWAY CLUB.

Windsor Hotel, Montreal,
November 9th, 1920

Members in attendance at this meeting are as follows:

Members Present.

Winterrowd, W. H.
Allen, C. D.
Armstrong, H. T.
Ayers, J. R.
Barrett, C. W
Bare, H. S.
Battley, E. R.
Beardshaw, A.
Blumenthal, S.
Boughton, L.
Brady, C.
Brandon, J. D.
Buchanan, R.
Buckland, A. W.
Buckle, W. E.
Burns, J.
Capwell, A. S.
Cameron, H. D.
Candlin, A. J.
Carter, J. W.
Cartwright, K.
Clark, W. G.
Clarke, J. E.
Coleman, J. W.
Coleman, Milton
Combe, F. A.
Comley, W. T.
Cowap, W.
Crawford, R.
Crockett, W. B.
Crumpton, A.
DeAngelis, G.
Delaney, O. J.
Doherty, A.
Dyer, W. E. L.
Dyke, H. J.
Eddison, E.
Ellement, T. W.
Elliott, W. C.
Fairchild, C. R.
Fradd, F. J.
Ferguson, J. P.
Fesmer, E.
Flynn, H.
Hamaker, R. A.
Harragin, H..C.
Harris, L. C.
Hatch, W. J.
Hendry, John
Hogan, Wm.
Holland, F. E.
Hudson, T. C.
Hunter, W. C.
Jarman, T. S.
Kastello, A.
Kearns, J. A
Keniston, C. R.
Kenny, J. P.
King, A.
Knight, F. C.
Langlais, W. S.
Liddy, S. J.
Linagh, R. K.
Loudon, A. C.
Lowe, W. S.
Luscombe, H.
Macken, Jas.
Mackie, R. L. D.
Meissner, O. W.
Mellor, C. T.
Michnevitch, J. R.
Mimms, A. E.
Monks, T. H.
Muir, J. D.
Murray, F. T.
McGoldrick, F. J.
McHattie, F. W.
McHattie, T.
McVicar, Robt.
Naylor, H. R.
Needham, R. J.
Newman, W. A.
Palme, J. E.
Parks, G. E.
Parsons, H.
Payne, H.
Peacock, G.
Plant, E. B.
Pope, A.
Pouphrett, W. F.
Powell, Jas.
Primeau, J. L.
Prouse, Wm.

Ogden, Jas.	Sharpe, H. W.	Thorburn, C. D.
Reynolds, P.	Shaw, J. A.	Tinkler, C.
Riddington, A.	Shortley, J. A.	Wheatley, J. H.
Robertson, J.	Spalding, E. C.	Wheatley, W. H.
Robinson, W. A. H.	Spence, Wm.	Winship, R. B.
Rosevear, W. H.	Soltau, G. R.	Yost, W. H.
Ryan, E. A.	Starke, A.	Young, C. E.
Saddler, E.	Stevens, G.	Booth, W. A.
Sample, W. H.	Taylor, S. G.	and others

Chairman (Mr. W. H. Winterrowd):

We will dispense with the reading of minutes of the previous meeting, as the Secretary informs me that these proceedings were mailed to you to-day.

While the Secretary is getting ready to read the list of applications for membership I will ask you to be sure to fill out the attendance cards which you will find on the seats, so that we may have a complete record of all who are here. We have thirty-five applications for membership. The Secretary will now read the names.

Secretary:

Mr. President and gentlemen, the following applications have been received:

NEW MEMBERS.

Bertrand, J. A., Schedule Foreman, C. P. R., Angus Shops, Montreal.

Boucher, P. D., Supt's. Secy., Canadian National Railway, Edmundston, N.B.

Buchanan, R. G., Canadian Pacific Railway, Windsor Station, Montreal, P.Q.

Champagne, E., Clerk, Grand Trunk Railway, 355 St. Ferdinand St., St. Henry, Montreal.

Cote, E., Charge Hand, Canadian Pacific Railway, Angus Shops, Montreal.

Crockbutt, W. B., Tool Shop Foreman, Canadian Pacific Railway, 100 Pine Ave. West, Montreal.

Davis, Wm., Clerk, Grand Trunk Railway, 584 Papineau Ave., Montreal.

Eddison, E., British Smelting & Refining Company, 1891 Clark St., Montreal.

Faughman, B., General Foreman, Canadian Pacific Railway, 2697 Hutchison St., Montreal.

Higginbottom, A. E., Car Inspector, Grand Trunk Railway, St. Henri Coach Yard, (Car Dept.), 2261 Notre Dame St. West.

Keel, F. A., Contract Foreman, Canadian Pacific Rly., Angus Shops, 364b 6th Ave., Rosemount.

Laduke, H. B., Manager, Boss Lock Nut Company, E. T. Bank Building, Montreal.

Lamarche, R. B., Painter, Canadian Pacific Railway, Angus Car Shops, 1377 Delorimier Ave., Montreal.

Mackle, H. J., Salesman, Can. Atlas Crucible Steel Company, 283a Regent Ave., Montreal.

Merryfield, J. A., Contract Foreman, Canadian Pacific Railway, 2705 Mance St., Montreal.

Morgan, W., Asst. Chief Clerk, C. M. E. Office, C. P. R., Room 1000 Windsor Station, Montreal.

Murgrove, G. W., Asst. Foreman, Canadian Pacific Rly., 1038 Des Erables Ave., Montreal.

McDevitt, H., Remington Typewriter Co., 282 Hampton Ave., Montreal.

McGoldrick, F. J., Sales Mgr., H. W. Petrie Co., 327 St. James St., Montreal.

O'Brien, W. D., Boiler Maker, C. P. R., Angus Shops, 1214 Dorion St., Montreal.

Palmer, W., Asst. Foreman, Canadian Pacific Rly., Angus Shops, Montreal.

Plant, E. B., Asst. Engineer, Canadian Pacific Rly., Room 401 Windsor Station, Montreal.

Ross, N. E., Chief Clerk, Car Dept., Grand Trunk Rly., St. Henri Coach Yard (Car Dept.), Montreal.

Saddler, E., Contract Foreman, 506 10th Ave., Rosemount.

Schofield, A. W., Foreman Bolt Shop, C. P. R., Angus Shops, 504b 10th Ave., Rosemount, City.

Scott, G., Clerk, Grand Trunk Railway, 488 Charlevoix St., Montreal.

Spalding, E. C., Chief Clerk to Frt. Traffic Mgr., Grand Trunk Rly., 94 McGill St., Montreal.

Talbot, A., Foreman Upholsterer, Canadian Pacific Rly., Angus Shops, Montreal.

Tyler, Jas., Asst. Foreman, Canadian Pacific Rly., Angus Shops, Montreal.

Vogin, L., Foreman Canadian Pacific Rly., Angus Shops, Montreal.

Watson, T., Contract Foreman, Canadian Pacific Rly., 529 Second Ave., Rosemount.

Wilding, G. G., Contract Foreman, Canadian Pacific Rly., Angus Shops, Montreal.
Will, Jas., Contract Foreman, Canadian Pacific Rly., 1707 De la Roche St., City.
Whitcomb, F. E., Mgr., Federal Signal Co., Room 1001 E. T. Bank Bldg., Montreal.
Wilson, Geo., Transportation Mgr., Canadian Consol. Rubber Co., 201 Inspector St., Montreal.

Chairman:
From the number of applications it is evident that we have some "boosters" in this club, —and as a matter of fact every member should be a "booster." You have heard the applications. A motion of acceptance is in order.

Mr. James Powell:
I move they be accepted.

Mr. T. McHattie:
Seconded.

Chairman:
It has been moved and seconded that these applications be accepted. Are all in favor?
Carried.

Chairman:
Gentlemen, we have a very fine paper this evening, prepared by Mr. R. H. Black, Engineer of Power Plant Construction, Grand Trunk Railway, Montreal, on the subject of "How to Heat Railway Buildings Economically." It is a paper that is both interesting and educational, and the discussion upon it should be very free. I take great pleasure in introducing Mr. Black to the meeting, and he will now read his paper.

"HOW TO HEAT RAILWAY BUILDINGS ECONOMICALLY."

Introduction

Heating systems in railway buildings often compare unfavorably with those used in buildings owned by private industrial concerns, the reason being that railways usually make their own installations, and the men employed are not

always heating tradesmen but are picked up from other departments and are not primarily interested in heating work. What they know has been learned from actual contact with other railway heating plants so that obsolete practice has a strong tendency to be perpetuated.

What is mostly needed is a compaign of education, and any railway contemplating extensive improvement in its heating systems would be well advised to study this problem from the start.

It is sometimes claimed that the use of steam traps and other devices is impracticable as they need too much care and attention. It will always be found, however, where such has been the case that the trouble lies in the want of care in choosing the right article or in properly protecting it from dirt and scale, or more often still, in neglecting to give the very small amount of attention which is needed periodically by all mechanism no matter how simple.

When it is realized that the modern air brake is far more complicated than the most elaborate heating system it will be conceded that there is no valid reason why the latter should give any trouble in the hands of the mechanics who are available at shops, and roundhouses, *provided they are given the necessary instructions.*

It is the intention of this paper to recommend a standard practice in designing new heating plants, and in remodelling those that are inefficient or out of date.

In so doing it is not sufficient to decide on a system that will be efficient if correctly operated, but to consider what chance it has of being correctly operated, or if it would not be better to make some sacrifices in certain directions rather than take a chance on personal equations that are beyond control.

For instance, it is needless to state that it is quite impossible to depend on anyone turning radiators on or off, with a view to economy *unless he is paying for the coal.* It simply is not done, and no number of circular letters or printed instructions will ever make any difference.

It therefore, remains to control the heat at its source, to make one man responsible, to make the system as automatic as may be, or to so arrange it that it is to somebody's personal advantage or comfort that economy be observed.

Also to pay the greatest attention to details, particularly in regard to protection from dirt, and external injury, and from being tampered with by unauthorized persons, and to arrange that waste becomes visible.

It is with the above ideas in mind that the following recommendations and suggestions are made, being followed out from the beginning and incorporated in the design.

PART I.

The Choice of a New System.

A heating system in its simplest form consists of a series of stoves placed in different rooms, and these are fairly economical, the possibilities of waste lying in the overheating of the premises (usually only occasional) and the throwing out of unburnt fuel with the ashes. This latter may be serious, but can only be due to carelessness, on the part of the attendant and the remedy is obvious.

Almost as simple is the Baker heater, which is often available when released from old cars, and works very well in a small building, where not more than one heater is required.

These two methods of heating are, everything considered, most economical for the smallest of passenger stations and small building, or sheds at a considerable distance from other buildings, and where they can be attended by baggage men, or other employees, in the course of their ordinary duties.

For stations of from 1,500 to 7,500 sq. ft. total floor area, which embrace the majority of ordinary stations, a hot water heating system should be used, with cast iron radiators, and sectional cast iron boiler, burning hard coal and placed for preference in a basement. In the smaller sizes, a hot water heating system is better than a steam system in many ways, although its first cost is about 35% more. The large volume of water in circulation acts as an ideal heat storage, giving up heat when fire is low and storing heat when the fire is bright, thus preventing to a large extent the losses due to overheating of the rooms, and calling for less attention to the furnace. Any man with a furnace in his home will know how to run such a system economically and will usually do so if for no other reason than to save himself trouble.

When we come to a larger station, such as is found at a division point, which is usually of two stories with offices above and sometimes a number of buildings arranged in a row, the hot water system may offer increased cost and construction difficulties which make it advisable to use a steam heating system.

In most respects the one pipe gravity steam system with boiler in basement using hard coal or other suitable fuel is the

most economical steam heating system that can be adopted, and it is certainly the simplest.

There is no possibility of waste of either hot water or steam when the proper air valves are used. Not only the radiators, but the boiler and piping themselves supply heat to the building, and need only be covered when they are likely to give out more heat than is required in the immediate vicinity. (Long horizontal mains also need covering to avoid excessive condensation.)

The system has the inherent disadvantage that the radiators must be either full on or off. However, with the boiler on the premises and the attendant firing it to suit fluctuating weather conditions, what actually happens is that the radiators are alternately heating and cooling, as not sufficient steam is made to heat them all the time, and this prevents overheating the rooms.

To take advantage of this feature it is most important to so arrange the piping that the colder rooms and more exposed portions of the building are given the preference by receiving their steam first. Otherwise, it will be found necessary to overheat one portion of the building in order to adequately heat another. With this attended to, it will be found that the system will work well for two or three buildings which are not more than 100 ft. apart and which have good basements, but under certain circumstances where there is a great difference in exposure or in distance from boiler to radiators it will be necessary to use special air valves on each radiator and connect them all to a small air pump, or ejector through a system of piping, which, however, need only be very small.

This is known as the air line system and has many recommendations, but is usually an unnecessary refinement for railway buildings.

In designing a one pipe heating system, proper size of piping, proper grading, and provision for expansion, and care in placing the radiators are the points on which the success of the installation depends.

We now come to the first condition in which there is a really serious opportunity for waste.

A station, office or small shop has to be heated, and as a supply of high pressure steam is available a short distance away at, say, the roundhouse it is proposed to use this. *Now it is usually not economical to do so.*

To begin with there is the loss of heat in the underground pipe supplying the building. With the very best construction this will be about 1% per 100 ft., but if the pipe is merely

buried in sand, or set in a wooden boxing the loss may be as much as 10% or more.

The condensed steam instead of draining back to the boiler direct must be separated by means of a steam trap. Certain of these steam traps will then return the condensation direct to the high pressure boiler with very little loss, but these traps need careful attention, as with a one pipe system should the trap stop working the system will rapidly fill with water, and it will take some time to get it working again.

The greatest loss, however, is due to the imperfections of human nature.

With an unlimited supply of steam from a distant point it will always be found that the building is overheated, and doors and windows left open even in very cold weather. In fact, radiators are rarely, and in some cases never shut off. One has only to imagine what his coal bill would be if he were to keep his furnace at home going full blast, from October to May, to realize what this means.

It may be argued that the agent or officer in charge should not permit this condition, but a second thought will show that this is one of all duties that can and will be neglected. The only practical way to control the heating of buildings is at the source of heat, and if the baggage man or other employee has to attend the furnace in addition to his other duties, *he will bank the fire to make it last*, and this is economy, which will far outweigh the difference in cost of hard and soft coal. It is more than likely that the cost of the underground piping and steam traps will equal or exceed the cost of a sectional cast iron boiler, and at even fairly large stations it will often be found possible to have a certain employee attend the furnace, in fact, where there are offices, a janitor is usually employed in any case.

What, then, are the conditions that make it advisable to heat a building from an external source of steam?

They are as follows:—

(1) When the building is very small, requiring only one or two coils or radiators, and is used by a number of men continually coming in and out. A switch shanty is a good example. There is no one to attend to a stove and the steam will not amount to much. In this case pipe coils may be used with a small steam trap on each coil, properly protected from sediment by means of a dirt trap or dirt pocket (a separator off a freight car is a good thing to use, and can often be obtained from stores.) The trap should have no by-pass and

should be non-adjustable, except by taking it apart. Run condensation back to the boiler room if not more than 200 feet away, otherwise let is drip outside *where it can be seen.* A reducing valve is not necessary, no great care need be taken in grading pipes, and as the steam is at high temperature only a small coil is required.

(2) When it is intended to heat an existing building, and there is no basement, or convenient place for a boiler, or when the building is quite large, over 15,000 sq. ft. floor area, and two or more stories, such as large stations or freight sheds, or two or more buildings some distance apart.

In this case the one piping gravity system is no longer the best to employ.

We come now to the two pipe vacuum system.

On the return end of every radiator, is placed a small steam trap, the discharge of which is led back through a separate arrangement of piping to a vacuum pump, which maintains a vacuum up to the outlet from every radiator. This means that all condensation is positively removed, and should the steam pressure at a remote part of the system be so low that the steam cannot flow into the radiator by itself, the trap, being cold, will remain open until the vacuum has drawn the steam in. Radiator traps should be thermostatic in principle and absolutely non-adjustable. Such a system is operated on a very low pressure, one to four pounds being sufficient in any well designed plant.

Its advantages are many, for besides the positive circulation which overcomes all troubles due to long distance and low pressure, it gives a low temperature radiator (an important point in economy, as it will not readily cause overheating), and also by using special inlet valves with graduated opening the so-called modulating system is obtained, which allows the heat in individual radiators to be controlled. This is a convenience, but as pointed out before, little economy can be expected therefrom, and modulating valves are only justified in the better grade of office.

The use of traps on every radiator safeguards the system from serious interruption, as the failure of a single trap only affects its own radiator, or at most those nearby, whereas the failure of a trap controlling the whole system may result in waterlogging the system for hours.

The vacuum system is not quite perfect, as it cannot be controlled from a central point. It can be made automatic to operate with thermostats but these are very expensive, ($50.00 per radiator), and need constant attention, so that its

greatest claims to economy are its low temperature, and absence of leakage.

It is very necessary in designing the building, to make provision for easy access to the heating pipes. If a proper basement is not provided there should be at least four feet of open space between the floor joists and the ground, or where mastic or tile flooring is used ample pipe trenches should be provided, which can be reached without destroying the floor.

The writer knows of a new station that has all the steam heating pipes buried in the sand beneath a terazzo floor. The piping will last for many years, but some of it will have to be renewed sooner or later, and at any time a leak may develop, which will necessitate the destruction of a large part of the flooring.

In providing water for wash basins a separate jacket heater or small boiler using hard coal is much to be preferred to a heating coil in the main boiler, and owing to the fact that hot water constantly renewed is extremely corrosive it is desirable to use brass pipe and fittings. Because of the expense extra heavy galvanized iron pipe is sometimes substituted but even this will give trouble in time.

Roundhouse heating is a problem in itself and a very difficult one in this climate.

It is well recognized that the hot blast system, in which a fan driven by mechanical power draws air through a nest of steam pipes, or cast iron sections and discharges it through ducts to different points, usually the engine pits, is the most satisfactory system that can be used.

It is not always recognized, however, what an enormous amount of steam is required to run these plants and they are therefore often made much too large for the boiler capacity provided.

Incorporated with a vacuum system to heat the offices the best way to remove the condensation from the blast coils is by connecting it to the same system, using a large size thermostatic trap on every coil. The fan should be engine driven as this permits the widest variation in speed, the exhaust steam being used in the coils.

Handling locomotives in winter is such a difficult matter that the most enthusiastic economist cannot justify fuel saving at the expense of cutting down the heat or reducing the ventilation in the roundhouse.

The only justifiable saving is that which prevents waste of condensation or steam.

In designing the air ducts it should be borne in mind that the speed of the air can be much increased over standard practice and therefore the ducts may be made smaller.

As these are usually most unweildy, at the large end, whether placed overhead or underground, this is a point worth remembering.

It is scarcely within the scope of this paper to discuss the heating of very large shops. It may be stated, however, that the writer favors forced circulation hot water in wall radiators combined in the larger buildings, with the hot blast system of hot air heating using live steam in the heating elements.

The generation of electricity by steam power and the use the exhaust steam as a by-product in the heating system is justified only when the alternative is the purchase of power from steam driven central stations, and is not justified where (as is usually the case in Canada) power can be obtained from hydro-electric development.

The suggestion is made that compressed air should be produced by steam driven machines, the exhaust being used for heating in winter and for generating about 25% of the electric requirements in summer by means of a mixed pressure turbine, the same turbine in winter using live steam, and exhausting into the heating system. Such an arrangement will require no increase in boiler capacity over heating requirements alone, would appear to offer a reasonable saving in power cost, and would provide a very valuable insurance against a complete shut down in the event of trouble with the external supply.

The provision of the correct amount of radiation or heat supply has an important bearing on economy.

In this climate it is necessary to somewhat increase the usual allowance taken as correct for the Eastern States, viz., 70 degrees room temperature with an outside temperature of zero.

For Eastern Canada 70 degrees at 5 below zero is about right. This will give a temperature of about 60 degrees at 20 below zero.

The above is for offices. For stations and shops the following is recommended:

Station waiting rooms..... 65 degrees at zero.
Machine, and erecting shops. 60 degrees at zero.
Forge and blacksmith shops.. 50 degrees at zero (when not working.)

Paint and varnish shops. . . . . 65 degrees at zero, with an additional section to maintain this temperature down to 20 degrees below zero.

Roundhouse . . . . . 60 degrees at zero, based on one air change per hour.

PART II.

Remodelling Existing Systems

We often find a boiler or boilers supplying steam to a system of pipe coils, the coils having valves at each end. The inlet valve is wide open, the discharge valve is supposed to be just cracked, discharging the condensation and also enough steam to make sure of it. The resulting steam and water are discharged into a so-called hot well, a wood or concrete tank placed underground, and the hot water is pumped back into the boilers.

Not so uneconomical on the face of it but let us see what is really happening. Some of the coils are discharging steam full bore for someone feels cold and wants all the heat he can get. Cold water is entering the hot well to make up the waste and as the float valve is out of order (for who can get in and fix it) it is overflowing to the sewer after being heated to boiling point by the steam from the heating system. The feed water is hot, there is no steam to be seen anywhere and no evidence of waste unless the singing of the steam through the coils means anything. There are a great many such plants still in use. Now what is the remedy?

To place a steam trap on the discharge to the hot well may answer but usually does not. The pipes do not slope in the direction of flow as they should, they sag and slope the wrong way and although they worked when there was a current of steam blowing out the water all the time, they will fill with water and stop the circulation if the pressure at the outlet is retained by means of a trap.

Usually such a system can be made to work economically by putting a steam trap on each radiator. These may be thermostatic or float but unlike vacuum traps they will be required to withstand a pressure of as much as 25 pounds and must be chosen accordingly. A reducing valve on the steam line should limit the pressure to this or less if possible, but it may be necessary to put in extra radiators to make up for the reduced temperature due to the lower pressure.

Unless the hot well is used as a storage for boiler washing it should be discarded and an open type feed water heater used. The returns from the heating system should return into this and will then be pumped direct to the boilers without loss of heat.

Steam traps which return the condensation direct to the boiler use much less steam than a pump and should be used when all the steam from the boilers is used in the heating system, but where much cold water has to be used as feed, the pump exhaust can be used to heat it and a pump is then as good as a trap and will usually be favored as being more easily understood.

The overflow from the hot well, where such must be used, should run over a wier where it can be seen and heard and a proper ball valve must regulate the supply of cold water but should be placed in a little pit beside the hot well where it can be reached.

Another type of obsolete system is a two pipe vacuum system using exhaust steam from engine or pumps, but with no traps on the radiators and none of the refinements necessary to a good job.

The back pressure on the engine is 10 or 12 pounds, the pipes and coils are partly choked with oil from the exhaust steam and as the steam is short circuiting through the nearer radiators, the more distant ones are difficult to heat.

The installation of radiator traps and some slight alteration to the piping will usually make quite a good vacuum system. The oil troubles can be prevented by means of an oil separator and the surplus steam relieved by a back pressure valve.

It is necessary to make special provision when using live steam that it shall not escape through the back pressure valve. A gate valve should be placed in the line to isolate this valve and the feed water heater when live steam is being used, a safety valve protecting the heating main from over pressure. This is a somewhat unusual arrangement, but is considered important.

The trouble with badly graded piping that cannot be readily changed may often be overcome by trapping it at the low points.

After an efficient vacuum system has been installed there is a great temptation to turn the discharge from high pressure steam traps or even open drains from steam hammers into the vacuum line. This must on no account be done as the temperature of the water leaving a high pressure line is around 100

degrees hotter than the temperature of the vacuum line and enough water will flash into steam to kill the vacuum.

If it is necessary to install additional radiators and no vacuum traps are on hand, their returns should be kept open until such traps can be obtained.

If a remodelled system using live steam at 25 pounds pressure exists at the far end of a low pressure vacuum system, which is often the case, and it is too costly to run a separate return back to the boiler, it may connect into the vacuum line with a spray of cold water supplied by a ¼" pipe to condense the steam.

One pipe heating systems supplied with steam from a distance and discharging their returns to the sewer through a partly open valve are fairly common and are rather difficult to handle. A continuous discharge trap of the float pattern or better still two connected in parallel well protected by large sediment pockets are the best than can be used for this service. If the system fails to heat properly with the traps in service which is quite possible, the trouble must be looked for in badly graded piping or piping too small. This is particularly liable to happen where the risers drain back into the steam main instead of into a separate return.

The next system is one in which the exhaust steam and perhaps some live steam is discharged to the hot well and steam driven pumps are used to circulate the hot water through pipe coils or radiators in the various buildings. A splendid system in principle it has gained a very bad reputation through poor design and inattention to detail.

Badly proportioned piping causes short circuiting of the water and consequent unequal heating of the coils. Insufficient surface and low temperature gives inadequate heat supply.

Oil from the exhaust steam mixed with pipe scale chokes the piping badly and corrosion due to air liberated from a continual change of water eats holes in the pipe in a few months.

Properly proportioned the heating is perfect. With centrifugal pumps forcing water through closed heaters there is no trouble with oil, scale or corrosion. Piping is much smaller than with steam, the multiplicity of radiator traps is dispensed with and all the advantages of thermal storage and control of heat at its source as claimed for the gravity hot water system are retained.

The system is applicable to the most remote buildings, in fact it shows to greatest advantage thus and is particularly adaptable for exhaust steam.

For large shops spread over considerable area its first cost is slightly less than that of a vacuum system.

In this system, as in every other, hot water supplied to wash basins and for other purposes (including boiler feeding) must be supplied by a separate system entirely.

Now let us take a typical case and see what can be saved by reconstruction along the above lines.

A roundhouse of thirty stalls built many years ago but in good condition and fairly modern as regards engine facilities may nevertheless have any or all of the following defects with their corresponding preventable waste of fuel.

Due to Bare Blower Line	127	tons per year
" " Obsolete steam driven compressor	163	" "
" " leakage of steam and loss of condensation from heating system in offices and stores	50	" "
" " feed water taken from hot well at a temperature of 130 degrees instead of heated to 210	140	" "
" " badly insulated underground piping	25	" "
" " exeessive back pressure on exhaust steam mains owing to absence of traps on roundhouse heating system	87	" "
	592	tons

When locomotive type boilers are used.

Waste due lower efficiency than return tubular boilers	100	tons per year
Waste due use of steam blowers for draft where same are used continually	200	" "
	300	tons

Where other buildings are heated the following preventable losses occur.

Due to loss of condensation, 25% above proper heating requirements when boiler pressure is used and 15% when boiler pressure is reduced to 10 lbs.

Due to leakage owing to absence of traps on radiators—5 to 50% above proper heating requirements, probable average 10%.

The preventable loss from underground steam mains, at

present buried in a wood box without any drainings or insulation amount to from 5 to 10 tons per year per 100 feet of pipe.

Proposed devices for improving steam economy at roundhouse.

Open type feed water heater	Heating boiler feed to 210° F.
Oil separator on exhaust main	Keep heating system at full efficiency by preventing it choking with oil and scale.
Back pressure valve on exhaust main	Regulate back pressure to minimum necessary.
Vacuum Traps on pipe coils or fan coils	Ensure even heating, full value from exhaust steam and minimum back pressure.
Magnesia or sponge felt covering on high pressure steam pipes	Reduce condensation to a minimum and provide a durable covering, reduce corrosion.
Asbestocel covering on low pressure and heating pipes	Assist steam circulation in heating system and provide durable covering which will prevent corrosion.
Reducing valves (properly protected by dirt traps) on live steam heating system	Provide maximum efficiency and reduce possible loss due to radiation and leakage.
Steam traps and return pipes on live steam heating system	Prevent loss of steam and return condensation either direct to boiler or to feed water heater, according to circumstances.
Float valves, readily accessible in hot wells, and visible hot well overflows	Prevent great loss due to hot water passing from hot wells unnoticed.

Underground steam conduit properly drained	Prevent loss of heat due to heating the ground and melting snow.
Replace shop engine with electric motor wherever possible.	Eliminate this wasteful use of steam.
Replace present obsolete compressor with new machine, either steam or electric driven	Old single stage compressor is inefficient as a compressor and as steam engine. Can save ½ of fuel it requires.

The replacement of locomotive type boilers can scarcely be justified at some points. It is doubtful whether these boilers are particularly inefficient when provided with good chimney draft and not forced above 70 boiler horse power, that is half the power of a standard return tube boiler.

When provided with poor draft and where forced by means of steam jets they waste enormous quantities of fuel and should be replaced as soon as possible.

Underground piping may be protected in various ways, but any really good method is very expensive and needs the most careful workmanship and supervision while being installed. For long distances with steam pipes of from 2½" to 10" and return pipes half the size, the split tile steam conduit cannot be beaten when proper attention is paid to grading and drainafe. It cannot be used under tracks unless protected by concrete walls or cast iron pipe.

The replacement of locomotive type boilers can scarcely be justified at some points. It is doubtful whether these boilers are particularly inefficient when provided with good chimney draft and not forced above 70 boiler horse power, that is half the power of a standard return tube boiler.

When provided with poor draft and where forced by means of steam jets they waste enormous quantities of fuel and should be replaced as soon as possible.

For distances of less than 200 feet a concrete trench with double board top screwed down to cleats set into the concrete may be used to advantage. The pipe covering should be sponge felt or diatamaceous material, magnesia is too fragile.

For piping above ten inches or where several pipes are to

be run a tunnel should be considered. For pipes smaller than 2½" and distances of not more than 300 feet, it is permissable to use a wooden boxing if the ground is dry as the loss in heat will cost less than the interest on the cost of the more expensive construction. If the ground is wet the pipe had better be carried overhead or if this is impossible it may be cased in an outer pipe which will just fit over the covering, the outer pipe being well covered with a mixture of pitch and sand.

All underground piping should be full weight with extra heavy couplings.

A few suggestions on the choice of apparatus have been added to this paper together with sufficient data to give a rough idea of the capacity and size. Complete information can only be obtained from the manufacturers of individual articles.

The recommendations cover type and not any special make. There are at least four different manufacturers of each type suggested.

PART III.

The Choice of Material

1. *Steam Traps,* stationary pattern. *High Pressure,* draining steam piping and steam separators.

Use open float, bucket type with valve and seat renewable and accessible by removing a small cap.

For Roundhouse blower lines place a ½" trap every 12 pits. For underground conduit use a ½" trap every 700 feet. Use a ¾" trap to drain main steam header on a battery of two or three boilers of 150-200 H.P. each.

Low Pressure,—draining one pipe heating system, or heating mains.

Use continuous discharge float type, easy accessibility of interior and integral by-pass and sediment traps are an advantage. Specify size and working pressure.

One—¾" trap will serve 800 sq' ft. of radiation.

One—1" or two—¾" traps will serve 1,600 sq. ft. of radiation.

One—1¼" or two—1" traps will serve 2,800 sq. ft. of radiation.

One—1½" or two—1¼" traps will serve 5,500 sq. ft. of radiation.

2. *Steam Traps, Tilting Pattern.*

Direct Return Trap, placed on top of boiler and discharging into it directly.

Three Valve Lifting Trap, raises low pressure condensate from heating system into direct return trap or storage tank.

Non-Return Trap may take the place of an ordinary trap when very large capacity is required.

These traps vary greatly in price, the cheaper patterns need greater attention, but may give good satisfaction. The sediment trap and necessary check valves are not included and must be ordered specially. Give size and working pressure and all possible information on proposed arangement as manufacturers should guarantee the installation.

¾"	trap	will	serve	4,000	sq.	ft.	of radiation.
1"	"	"	"	7,000	"	"	"
1¼"	"	"	"	12,000	"	"	"
1½"	"	"	"	20,000	"	"	"

3. *Radiator Traps. Vacuum System.*

Use traps working on the thermostatic principle which are non-adjustable. They should be guaranteed to operate under a maximum pressure of not less than ten pounds and a higher pressure is often a great advantage.

Medium Pressure.

These should be similar to the foregoing but guaranteed for a maximum working pressure of not less than twenty-five pounds.

High Pressure,—should be as above and guaranteed for a maximum pressure of 100 lbs. A certain make of float trap having a plain floating ball may also be used to advantage in this and the foregoing type.

As the smallest radiator traps are about 100 sq. ft. radiation capacity it is rarely necessary to use any larger.

4. *Vacuum Pumps,*—if steam driven should be fitted with a mechanical force feed lubricator, very small hydrostatic lubricators are unsatisfactory.

Vacuum pumps are often much too large, a 5" x 6" x 6" pump will care for 7,000 sq. ft. madiation, a 6" x 9" x 10" pump is sufficient for 25,000 sq. ft. of radiation.

5. *Pressure Gauges,*—to register pressures up to 5 pounds are often very inaccurate. For such low pressures a compound gauge reading from a perfect vacuum up to 15 pounds pressure

should be used. Care must be taken to avoid water pockets in piping which may add hydrostatic pressure to the gauge.

6. *Air Vents*,—or air valves for use on steam radiators should work on the spyhon principle having a floating member. Thermostatic valves are liable to cause flooding.

Recommended Practice for New Heating Plants

Wayside station and small buildings	Stoves or Baker Heaters.
Station 1,500 to 7,500 sq. ft. floor area	Gravity hot water heating system with cast iron boiler and hard coal.
Other guildings 7,500 to 13,000 sq. ft. floor area	1-Pipe Gravity Steam Heating System with cast iron boiler burning hard coal.
Stations to where high pressure steam must be supplied for heating coaches	1-Pipe boiler return trap system with boiler in basement or 2-pipe Vacuum System with boiler at a distance.
Stations, Hotels or large exposed buildings 11,000 to 15,000 sq. ft.	1-Pipe gravity steam system with vacuum air line and down draft boiler using soft coal.
Stations, Hotels or large exposed buildings 11,000 to 15,000 located near Power Plant	2-Pipe Vacuum System using steam from Power Plant.
Small and medium sized shops	2-Pipe Vacuum System or forced circulation hot water system using wall radiators.
Large shops	Forced circulation hot water and live steam fan coils.

Roundhouses . . . . . Live or exhaust steam or both in fan coils and wall radiators in machine shop and offices.

RECOMMENDED PRACTICE FOR REMODELLING HEATING PLANTS

(1) *High Pressure Two Pipe System.*

Reduce pressure as low as possible, 15 to 25 pounds using a trap on each radiator. Return condensation direct to boiler by means of tilting traps if steam is used only in heating system. If steam is used for other purposes, use open feed water heater and boiler feed pump.

(2) *Two Pipe Vacuum System Using Exhaust Steam.*

Use thermostatic trap and sediment pocket on each coil. Install oil separator, back pressure valve and reducing valve so arranged that live steam through reducing valve does not reach feed water heater or back pressure valve. Place thermostatic traps on low points in heating main and cover heating mains if these are too small.

(3) *One Pipe Heating System Low Pressure, Supplied From a Distance.*

Discharge condensation to return line through two continuous discharge traps in parallel, well protected by sediment pockets or use boiler return traps if these can be arranged in boiler room.

(4) *Forced Circulation Hot Water System.*

Install closed water heaters and operate a "closed" system, using the same water in circulation indefinitely. Install separate system for wash basin and bath supply, using extra heavy galvanized pipe (brass pipe is used in hotels and offices) as a fresh supply of hot water is very corrosive.

Chairman:

Gentlemen, this certainly is a most interesting and instructive paper. It is now open for discussion, and I feel this discussion should be most thorough. This is a subject that is a most important one to us to-day, particularly in view of to-day's cost of coal. I have no doubt there are many here who have provided means or worked out systems to check existing methods and make sure they are worked to their maximum efficiency. As I said at the last meeting, if there is anyone

here who does not feel in position to contribute to the discussion, but would like to ask any questions, we shall be pleased to hear from him, as I am sure Mr. Black will gladly answer any questions. Let us make this a get-together gathering and all join in making an interesting discussion.

Mr. A. E. Gulliver:

Speaking of traps: I fear a great many do not quite understand what Mr. Black means when on page 31 of the paper he refers to purchasing traps on the square foot of radiation they will drain. It is impossible to rate the capacities of steam traps on the square feet of radiation. This practice is to be blamed for many trap failures. If we select a trap to drain 4,000 square feet of radiation, we are just as likely to get it too small as we are to get it too large for the purpose required.

In the first place, the average man assumes 4,000 feet, just that and no more. To feed 4,000 feet of radiating surface requires a steam line to and a return line from the radiator to the trap, there will be condensate from these lines, therefore they must be taken into consideration. Then again the amount of condensate that 4,000 square feet of radiation will produce will not be the same in all cases, and depends upon the temperature of the steam in the radiating surface and that of the surrounding atmosphere. The quantity of condensate that a trap of a certain size will handle will vary as conditions vary. Every time the trap operates, it discharges so much water, no more, and no less. The same trap may operate continuously or intermittently. It may operate 20 times an hour or it may operate 50 times an hour.

I agree with Mr. Black on the elimination of the by-pass. I think that they are apt to be very wasteful, and would prefer in the event of a trap being removed for repairs, that the drip be led to some convenient place so that you can see just what condensate is passing through it.

I would suggest that a gate valve be placed on the discharge line from traps, and a tee short nipple and valve be placed just inside of the gate valve so that at any time the gate valve on the discharge could be closed, and the other valve opened to the atmosphere to see whether the trap is working O. K. or blowing live steam. This same connection can be used for testing purposes if it is desired to weigh the condensate from the trap under any particular condition.

Another thing to be taken into consideration in the selection of a trap is the steam pressure behind it and the conditions in front of it. If we have a resistance ahead of the

trap due to check valves, elbows and pipes; in fact, anything that will cause resistance, this will effect the working of the trap, and without knowing these conditions it is difficult to select a proper trap for the work.

Mr. R. H. Black:

This principle was merely used to get a rating for the trap. You have got to rate them in some way, and the best way to do it is to have some definite ratio. This square feet of radiation is based on a temperature on the outside of the radiators of 70 degrees. Anything lower than that will increase the radiation. What would you suggest as a better method?

Mr. A. E. Gulliver:

We usually figure a square foot of direct heating surface will transmit 1.6 B. T. U. for each degree of difference in temperature between the steam in the radiator and the surrounding atmosphere.

Mr. R. H. Black:

A great many men who are required to select traps are not capable of figuring that out and you have got to give them something to guide them. The capacities shown in this paper are from 25 to 50 per cent below the manufacturers' ratings to allow for unusual conditions.

Mr. A. E. Gulliver:

Speaking of manufacturers' ratings, I have looked at a great many catalogues of traps and I do not think there are any two makers alike.

Mr. R. H. Black:

One of the reasons for advocating a certain type of trap is because they have a definite discharge ratio. It must be remembered that these traps are not selected by experts but by the average man.

Mr. A. E. Gulliver:

I would suggest that the selection and installation of traps be left to someone who knows more than the average men. It should be done by an engineer who can figure out the requirements after taking all the conditions into consideration.

Mr. R. H. Black:

That is the ideal condition. I fear the railways have not reached that state of perfection yet, and we have to make the best of the circumstances.

Mr. A. Kastello:

I do not quite understand Mr. Gulliver's remarks with reference to determining the proper size of trap that may be required for taking care of condensation of radiators, steam mains, hot water heaters, etc. We have on the market to-day what is called a low pressure and a high pressure trap. Most of the low pressure traps are being used on heating systems. To select the proper size of trap for each radiator or pipe coil, it is only a matter of figuring out the radiating surface of these coils and you will immediately find the total amount of radiating surface on each coil. It is practically standard to figure one-quarter pound of water per square foot of radiation per hour for all direct heating systems. The high pressure traps are being used on high pressure steam main drips, and in other cases, where high pressure steam is required for manufacturing purposes of different kinds. I quite agree with Mr. Gulliver that in some cases it is very hard for the average engineer to figure on the capacity of these high pressure traps. In this case, if the manufacturers of these traps are requested by the owners or engineer, to visit his plant, I feel satisfied that he will be only too glad to do so, and figure out the amount of condensation per hour or per day, that will be required to be handled by the trap, and he will then give him the proper size of trap that he should order.

Mr. A. Gulliver:

I am not figuring on increasing the radiation but keeping it just where it is. A lot of men will select a trap and instal it on a line out in the open leading to a train lien for heating coaches and expect it to take care of the square feet of radiation.

Mr. A. Kastello:

I must again repeat the remark which I have made before that there must be absolute understanding that when you figure the condensation one-quarter pound of water per square foot of radiation per hour, same thing cannot be applied to high pressure traps, especially considering the different conditions that these traps are applied to.

Mr. A. E. Gulliver:

If that manufacturer is going to supply a special trap for a certain purpose and has figured on the various conditions the temperature of the steam in the radiator and the temperature of the surrounding atmosphere, as well as the other conditions, he will probably furnish a trap that will meet the requirements, but if he has not done so he will not.

Mr. E. Kastello:

It is the general policy of the trap manufacturers to avoid unnecessary troubles, and therefore he will do his best to ascertain the correct size of traps that are required for different functions that the traps should perform.

Mr. A. E. Gulliver:

That is not the point. It is getting back to the employee ordering the trap on the square foot of radiation to be drained and without taking other conditions into consideration. If he does that he is not going to get a trap that will do the work.

Mr. J. A. Shaw:

I should like to obtain some information from Mr. Black on the laying out of hot air heating systems for roundhouses. One meets the hardest problems of maintenance in such a building. If the ducts are placed underground then with the settlement of the building these ducts will crack, and the heating system becomes very inefficient in a very short time, through becoming a drain. The practice to-day is to place ducts overhead, but as the atmosphere in a roundhouse is saturated with diluted sulphuric acid, the result is that even with the constant application of paint, the life of ducts is comparatively short. I should like to know if Mr. Black has any informatioin relative to replacing the sheet metal with fibrous material, cement, or similar material.

Mr. R. H. Black:

I have never seen any fibrous material or cement duct carried overhead. One of the greatest difficulties in that would be in shipping the ducts ready to be installed in the hot air system, as that job is generally handled by the tinsmith who puts the fittings in place as they come along. They roll the pipes and make the elbows right there on the job, and it would be a difficult matter to design the system and ship it out complete. The use of sheet metal, galvanized and well

painted, is fairly satisfactory. Some of our installations have been in use for ten or twelve years, and it looks as if they would last for a long time yet, but I rather favor the underground duct provided you can get good drainage, but if not I would put the system overhead. If you can get a good foundation the little settlement in the building will not bother you to any great extent. These ducts are usually made too big. In a 30-stall roundhouse you can cut them down to about three feet square.

Chairman:

We have with us to-night several guests. I am going to take the liberty of calling upon some of them. Is Mr F. R. Still of the American Blower Company here?

Mr. F. R. Still:

Mr. President and members: This question has taken a rather peculiar angle by the discussion reverting entirely to traps. It seems to me that the most important paragraph in Mr. Black's paper is one that I would not presume to say anything about were it not that the question is raised in the paper, and I think, from the discussion which has taken place, a great deal of the indecision in the minds of those here is due to the fact that the heating of buildings is not a part of your profession. There are men whose business it is to know all about such things, who know what will give the best results, and it seems to me it would be to your advantage to engage the men who make a specialty of the subjects of heating and ventilating, as well as condensation and its disposal. You would thereby avoid a lot of the things which are apt to cause you grief and possibly censure from those higher up. Heating and ventilating engineers work to more exact standards in some respects than almost any other profession, with less allowance for unforeseen difficulties than any other line of engineering, such as the civil engineers who designs bridges or the mechanical engineer who designs machines. When the bridge engineer, for instance, starts out to figure the stresses on a bridge he makes careful computations and graphic diagrams; the whole thing is figured down to the finest point; then he applies a factor of safety of five or ten, thus discounting his calculations about 80%. We do not have any factors of this kind in heating.

I think it is gradually becoming the custom to rate all traps on the maximum amount of water they will handle without resistance; then determine from tables or diagrams what

the trap will handle when there is a definite amount of resistance. That is the right way of doing it.

At the present time I am chairman of the Bureau of Research Committee of the American Society of Heating and Ventilating Engineers. We are following up a very interesting work, started some years ago by Prof. John R. Allen, which is now nearly completed. He carried on exhaustive work in an effort to definitely establish and standardize a method to employ in the separation of radiation from convection. This is a subject upon which efforts have been made to solve it for sixty or seventy years, and he has only recently accomplished it. The object of it is this: When you adopt a specified size of trap for a given size of radiator it makes quite a difference as to how much of the work is to be done by radiation or by convection. If you take, for example, one of the radiators in this room and then place it in a greenhouse; in this room it may condense one-quarter of a pound per hour per square foot of surface and as much as one pound in the greenhouse. I think if Mr. Black adopted the pounds of condensation basis he would get better results from his traps.

Mr. R. H. Black:

That is all very well for myself, but the foreman out on the road could not figure this out.

Mr. F. R. Still:

No, that should be done in the Engineering Office.

Mr. R. H. Black:

Yes, but the point is that under present conditions it is not done. I might say that a short time ago the Purchasing Department received a requisition for a three inch tilting trap to drain an ordinary station heating system—you know what that means. I am trying to get away from that. If a man takes the information given him in this paper he will not order a three inch tilting trap to drain a station.

Mr. F. R. Still:

The question was raised about heating roundhouses. We put in a plant 15 or 18 years ago in the D. & R. G. roundhouse at Denver. It was a 42-stall roundhouse, having overhead galvanized iron ducts. These ducts, I believe, are still in use. We have another plant installed at Lafayette, Indiana, for the Wabash Railway, in which latter the ducts only lasted about four years. We put in new piping, also smokejacks over the

locomotives and the heating system has now lasted perhaps six years and is still in good condition. The trouble was overcome by the application of smokejacks so as to keep the dew-point at the proper degree; then there is no trouble with sulphurous dioxide. I would prefer the use of vitrified sewer pipe where it is available, but sometimes you cannot get it. One practice that is in use in many roundhouses, particularly the New York Central, is to lay the ducts so they will not abutt against the outside wall. I think these ducts should be kept separate from everything else. You can run these ducts overhead if you have ample supply of air, but with the volume of air insufficient to keep the dew-point down, then you will likely have a fog in the roundhouse, with the result that the galvanizing will peel off the pipes.

Mr. R. H. Black:

Will that apply more in the summer than in the winter? In the winter the temperature of the duct would be higher.

Mr. F. R. Still:

My observation is that it only applies in the winter. In summer when the fan is not running, the same conditions do not prevail and there is no chilling effect to cause deposit of moisture on the ducts.

I want to add this statement before I sit down: I am most disappointed that neither the paper nor the discussion touched on the heating of large shops, which is by far the most interesting and most difficult problem in the whole field.

Mr. R. H. Black:

It is a subject for a separate paper.

Mr. A. E. Gulliver:

Speaking of heating and ventilating by the use of engineers' figures, I know of one case where they had a hot blast system with a duct of 5 ft. 6 in. in diameter which goes outside of one shop and 20 ft. into the atmosphere, at 25 degrees below zero. That was designed by a heating and ventilating engineer.

Mr. F. R. Still:

There are "black sheep" in all flocks, you know.

Chairman:

I might say that there is another kind of figuring which

Mr. Gulliver has not yet mentioned. His duties at Angus Shops include supervision of the heating; he is continually figuring the foremen to carry out his instructions. If a shop door is left open during cold weather, he wants to know why.

There is a system at these shops by which from approximately May 1st to October 1st. (Mr. Gulliver can check me on these dates) for the last two years there has not been one pound of coal burned in the boiler plant. Dutch ovens have been put in front of some of the water tube boilers and in these ovens is burnt the refuse from the car repair tracks. Steam is supplied for air compressors, steam hammers and other purposes around the plant. With coal at its present price you can appreciate what that means in a big plant like Angus.

Mr. A. E. Gulliver:

Speaking of figures in this connection. For the months of June, July, August, September and October, 1920, we have not consumed a pound of coal. Our evaporation during these months, which has amounted to 88,219,000 pounds of water, had been accomplished with scrap wood as fuel. Assuming an evaporation of 7 pounds of water per pound of coal, the quantity of water evaporated for the above 5 months would represent a saving of 6,301 tons of coal. The average price of coal during the above five months was approximately $8.00 per ton, so that the 6,301 tons of coal saved represents a value of $50,408.00.

During the above period 857 cars of scrap wood were consumed for fuel, and quite recently some of this scrap wood was sold at $17.50 per car load, on this basis the 857 cars of scrap wood consumed as fuel would represent a value of $14,997.50.

It will be seen from the above that had we used coal as fuel during the above period the cost of same would have been $50,408.00, and the cost of the wood actually consumed was $14,997.50, which represents a saving of $35,410.50.

From the 875 car loads of scrap wood consumed we reclaimed 140 tons of scrap iron classed at No. 2 scrap at $25.00 per ton, representing a value of $3,500.00. This would bring our saving for the above period up to $38,910.50.

Mr. O. Elliott:

One question I would like to ask Mr. Black is if we are to understand from his paper that he considers the air in a roundhouse should be changed once every hour?

Mr. R. H. Black:

No. The heating is based on an air change once per hour. There is considerable heat given out by the locomotives themselves and you have got to figure on heating of the roundhouse somehow and must take some basis to work on. You may remember the Elsdon roundhouse was figured out this way and it was very successful.

Mr. F. R. Still:

Regarding the question about the proper velocity to move air in ducts. We have capitalized the velocity for different purposes in commercial work and have found that a velocity of 2,400 feet per minute represents about the best average velocity for ordinary practice. You cannot drive the air at this velocity, however, in buildings such as churches or schools owing to the noise as the air whistles the same as when a strong wind blows outside.

Mr. A. E. Gulliver:

Speaking of the heating of large shops, Mr. Black states at the bottom of page 23 that: "The generation of electricity by steam power and the use of the exhaust steam as a by-product in the heating system is justified only when the alternative is the purchase of power from steam driven central stations, and is not justified where (as is usually the case in Canada) power can be obtained from hydro-electric development."

I do not agree with Mr. Black in this statement, and I am not quite sure if Mr. Black agrees with it himself, for in the next paragraph the suggestion is made that compressed air should be produced by steam driven machines, the exhaust being used for heating in winter and for the generating of about 25 per cent of the electric requirements in summer by means of a mixed pressure turbine, the same turbine in the winter using live steam, and exhausting into the heating system.Such an arrangement will require no increase in boiler capacity overheating requirements alone, would appear to offer a reasonable saving in power cost and would provide a very valuable insurance against a complete shut down in the event of trouble with the external supply.

In this latter statement I most certainly agree with Mr. Black, for if it is possible for us to generate power and do our heating at the same time with no extra cost I think that in the interest of economy it would be justified, whether there is hydro-electric development in the vicinity or not.

Contracts for purchased power from central station should be made with permission for the consumer to manufacture what power is desired to obtain sufficient exhaust for heating purposes during the winter months.

An example in this respect can be taken from the Westinghouse Co. when they built their new shops on the Delaware River, just south of Philadelphia, and desiring to make use of central station power, and at the same time secure steam for heating economically, the management entered into an agreement with the Philadelphia Electric Co. that works well for both companies. Steam heat is required in the winter months but this demand falls off, naturally, in summer, when no steam is required. On the other hand, during the winter months, the Philadelphia Electric Co. has a heavy load ,which is materially lessened during the summer months.

An agreement was effected whereby the Westinghouse Co. operates its own plant noncondensing, during the winter and utilizes the exhaust steam, and when there is no need for heat, current for the operation of the works is secured from the Philadelphia Electric Co.

Many are of the opinion that exhaust steam is of little value, and is to be treated as a waste product. The value of exhaust steam is equal to live steam of the same pressure. The steam engines, turbines, or hammers only acting as pressure reducers, and the power generated by these units becomes a nearly costless by-product, or on the other hand, the heating is practically free of charge.

Steam turbines, engines, hammers or equivalent machinery taking steam at any pressure and exhausting into a lower pressure does not take from the steam a very high per cent of its total heat. For example: a turbine or equivalent machine taking steam at 100 pounds pressure, and exhausting at 10 pounds pressure, the pressure drop would be 90 per cent, whereas the drop in total heat would be approximately only 2 per cent.

It should be remembered that while a power plant utilizes only 8 to 15 per cent of the energy contained in the coal burned, a heating plant uses about 75 per cent during the winter.

Yet in many of our large plants, electric current is being purchased for power, while at the same time coal is being used to produce live steam for heating purposes. In my opinion, the operation of a large heating plant, without the production of the by-product power is wasteful.

Mr. F. A. Combe:

With reference to different heating systems, there is one in connection with the heating of several buildings from a central source of steam, which was not touched on in the paper but which might be mentioned, although its field is somewhat limited. I refer to steam heaters—taking the place of furnaces—in the basements of the buildings, with a regular gravity hot water system of heating. This has considerable advantages, especially in mild weather when more moderate heat is required than can be obtained with any method of direct steam heating, while all complications, such as air valves, vacuum lines, pumps, etc., are avoided. Mr. Black has pointed out the difficulty in obtaining efficient control of steam supply, but with this system thermostatic regulation of the steam supply to the heater governed by the temperature of the return gravity line can be simply and satisfactorily arranged. In any case, for buildings of any considerable size, it will be found advisable to make it one man's duty to look after the supply of steam and regulation of the heating system as the economy effected will save his wages several times over.

There is one other point, in connection with underground piping, for which the paper mentions full weight pipe and extra heavy fittings. Does Mr. Black consider it worth the difference in cost to put in wrought iron pipe for underground conduits? Several years ago, we put in a lot of steam and water lines in conduit and we were particular to use "Byers" wrought iron pipe, but after a few years the couplings gave out. Whether the couplings were wrought iron or not I cannot say, although they were supplied with the pipe, but the fact remains that the couplings were corroded away and the pipe remained sound. I would like to know whether it is your practice to use wrought iron pipe for that service or whether you use steel pipe.

Mr. R. H. Black:

We use steel pipe in Canada for the reason that it is difficult to get wrought iron pipe. It has to be ordered specially and takes some time to get delivery. For this reason we have no experience with wrought iron pipe.

Mr. A. S. Capwell:

I do not know that I have much to say in this discussion, but perhaps some of the gentlemen present would be interested in some new developments with the hot blast system of

heating which have taken place within the last year or two.

In the past, as far as this system is concerned, the amount of air, as well as the velocity used, have been practically fixed quantities. Our company, however, have recently made several installations which have operated very successfully using the ejector principle for discharging the air, and instead of using large pipes with low outlet velocity, we have installed small pipes with high velocity, which has, of course, very materially reduced the cost of installation. A short pipe of large size, running about eight to ten feet high, is used with a smalled discharge pipe from the fan entering same, thus employing it as a nozzle to keep up a circulation of air near the floor level.

In this way we are able to employ a primary temperature of 200 degrees, whereas with the ordinary system and low outlet velocity about 140 degrees is the highest temperature that can be used with comfort to the men. This arrangement delutes the air so that the final temperature, as well as velocity are practically the same as with the ordinary system.

One of the objections to the hot blast system has been that the heat rose to the roof, resulting in rapid cooling, and a large amount of condensation, but the system as described above has the advantage of keeping the warm air in circulation within the breathing zone without roof radiation losses.

Another advantage is that where shops having crane runways require to be heated, it is possible to run small pipes down back of the crane girders, whereas with the large diameter ducts in use with the ordinary system this has been practically impossible, and it has been necessary in many cases to run concrete ducts below the floor at very great expense.

I trust that a sketc hof this system may be interesting to you as it is entirely different from the old practice so long followed by heating engineers.

Mr. G. A. Powell:

With reference to the galvanized iron ducts. We have it in use but it has not been in service sufficient time to make the test final. When final data is obtained we will give it out. For underground work I would recommend a heavier gauge iron well coated with rust-resisting paint.

Mr. J. A. Kearns:

Just a few points. The paper states in one place that it is desirable to use high pressure steam for certain buildings. In this case I should like to know if it was found advisable to

use extra heavy fittings or special coils on account of the high pressure. I would also ask if he finds it necessary or advisable to use steam in the blast coils.

Mr. R. H. Black:

It seems to me that you are going to considerable trouble in using water in your ventos. The temparature of the steam can be controlled in the steam coils practically as well as it can in the ventos using hot water, and if you take air from the outside you are liable to freeze your ventos.

Mr. J. A. Kearns:

The force hot water system of heating is very economical and practical, for the reason that by proper design everything can be controlled from a central point in the heating of groups of buildings, but I should like to know if Mr. Black or anybody else present can give me figures to show which has been the most economical and practical in connection with railway buildings.

Mr. R. H. Black:

I do not feel capable of discussing the heating of very large shops when it comes to a fine point like the use of hot water in ventos, but with regard to your other question concerning the use of extra heavy fittings for live steam; I presume you refer to the small building. We always use coils. We do not use cast iron radiators, and usually the fittings obtained are car heater fittings.

Mr. J. B. Bladon

Mr. Black has covered such a wide field so thoroughly and consisely and opened up many interesting points for discussion, but our time is short so that I will only make a few remarks.

Mr. Black thinks that heating systems in railway buildings often compare unfavorably with those of private industrial concerns, due to employment of men not familiar with the work.

I have had more experience with industrial concerns than railway buildings and it is surprising how many buildings some people are attempting to heat without any real "system."

The heating system is often put in by the "handy man" around the plant, and just grows like Topsy did. It is most important that some "system," such as one of those Mr. Black

has explained to us, should be adopted in the first instance and method used in its operation.

After a system has been chosen it should be installed to a prepared plan, by a competent steamfitter, and endless worries will be avoided. I quite agree with Mr. Black, when he advises the use of a hot water system for small isolated buildings—especially dwellings—as any ordinary individual can attend to a hot water furnace. A steam or vapour system requires a little more thought and intelligence to run it, but when it is properly looked after such a system has its own advantages as well as those of a hot water system.

One great advantage of a steam system is that it is more elastic than hot water; in this way, that it can always be added to up to the full capacity of the mains without disturbing the balance of the system.

A very convenient way to hitch up an old hot water system to a power plant is to replace the hot water furnace with a hot water converter. A temperature regulator may be applied to the steam inlet and the return trapped back into a receiver or vacuum return line. Steam is turned on in the fall and it requires no further attention until turned off again in the spring. This arrangement gives a uniform temperature in the radiators and invariably gives good results.

Chairman:

The evening is getting late, but before the discussion closes, I should like to ask Mr. Black one question. I understand that at the present time some experiments have been made in conveying superheated steam long distances, the idea of the superheat being to reduce the loss from condensation and bring the steam to the point of use at a much higher temperature than ordinarily. Steam is superheated by waste gases from the boiler. I would like to know if much is being done along these lines in connection with railway heating installations.

Mr. R. H. Black:

We have considered this question. It is being used in one shop but the saving in a heating plant is problematical. If you can superheat the steam by using waste gases no doubt there is a saving, but if this cannot be done and it costs as much to superheat the steam as to evaporate it, you are then increasing your losses from the steam main, due to the higher temperature. On a supply main to steam hammers we de-

creased the steam pipe from 5 in. to 3½ in. without any reduction in the pressure and a decided saving was effected.

Mr. H. R. Naylor:

I do not claim to be familiar with all the heating problems we have had so well described for us this evening, and I am unable to discuss the various formulæ available for the proper heating of buildings, but there is one formula that I have been greatly interested in for some time. The chairman in asking for the opinion of foremen and others on shop heating, again reminds me of the need for this formula.

A fairly large car shop has during the last two years been delivering scrap wood in large quantities to a certain power house, the actual loads I could only guess at, but I understand its value from a heating standpoint when figured out occasionally bears a very close resemblance to the national debt. I also understand that in these car shops it is quite a common thing, on the approach of the power house engineer, to observe the foremen and their assistants making a bee line to close very quickly any door or window that may have slipped open, for to do otherwise might lead to detailed explanations and complications later on. In view of the fact that these shops have supplied in scrap wood the entire fuel of the power house for so long a period, also supplied it gratis and free of all charges, it has occurred to me that a formula could be figured out, which would entitle them to a larger measure of consideration in the future. (Laughter.)

Mr. A. E. Gulliver:

I would like to say a word on that. From this wood you speak of we reclaimed iron that your men formerly obtained by taking the wood down to the end of the yard and burning it in the open in order to get the scrap, and while this reclamation work was formerly handled by Mr. Naylor, now I have to pay for it. (Laughter.)

Secretary:

Mr. Chairman and Gentlemen:—

I would like to tell you of a unique system of heating that I was looking over a short time ago.

Pipe coils are used and the steam enters at the bottom instead of at the top as is usually the case, and as the steam condenses it builds up and fills the radiator with water which extends up to a syphon; and as soon as the water goes beyond the point of equilibrium, the syphon discharges th esurplus con-

condensation into the drain until such time as the whole movement creates a vacuum in the steam chamber. This action takes place continuously as the water builds up and is being discharged. This system works out very well and I believe is fairly economical.

Then in the event of steam being cut off at the main source the condition changes altogether and the heat in the coils will rise and keep the building comfortable for a considerable time.

The President has stated that the time is getting late and I should like to take this opportunity of moving a vote of thanks to Mr. Black for his instructive paper, also to the other gentlemen who have taken part in the discussion this evening.

Mr. J. Powell:

I take pleasure in seconding that.

Chairman:

There are no doubt a number here who could contribute to the discussion, but the time is very late. If those who wish to contribute will put their remarks in writing and send them to the Secretary they will be incorporated in the minutes. It has been moved and seconded that a hearty vote of thanks be extended to Mr. Black for his interesting paper. All in favor please signify.

Carried. (Applause.)

Chairman:

The subject for next meeting will be "Every Day Duties of a Roadmaster," and the paper will be given by Mr. E. Keough. Asst. Engineer, Maintenance of Way, Canadian Pacific Railway, and I understand it is to be illustrated with lantern slides. It should be very interesting and I hope everyone here will attend and bring someone else with them. The Secretary has provided some light refreshments and these will be served in the room at the rear. A motion to adjourn is now in order.

A Member:

I move we adjourn.

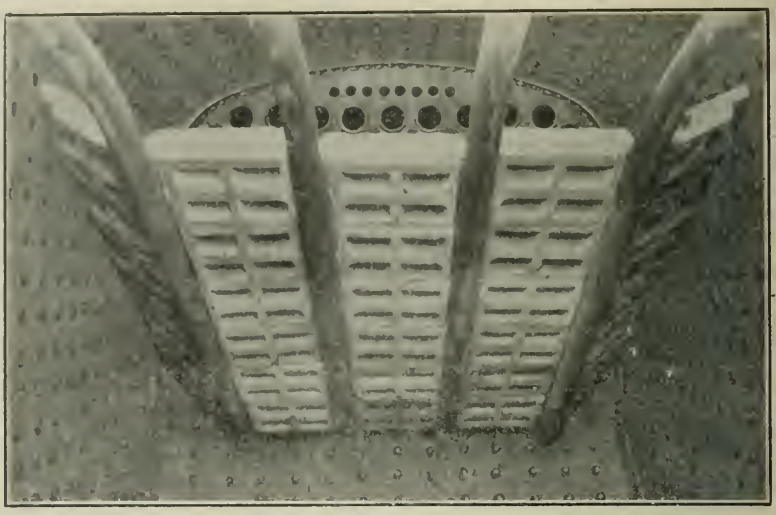
Another Member:

Seconded.

Chairman:

Moved and seconded we adjourn.

Carried.



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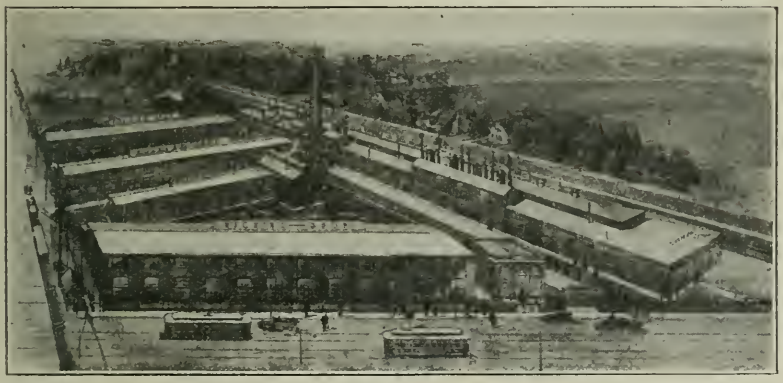

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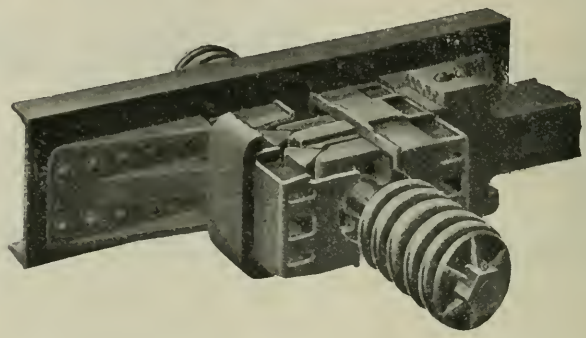

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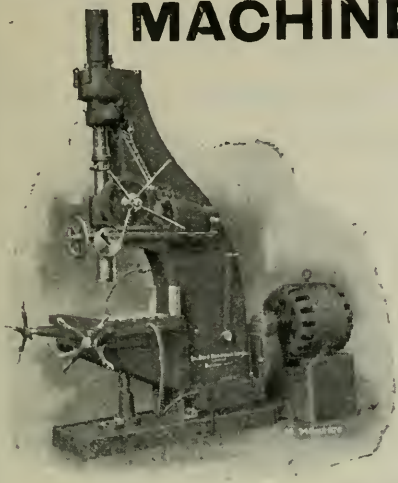

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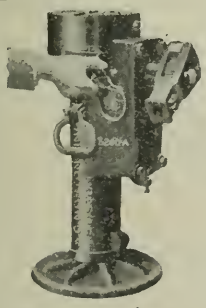

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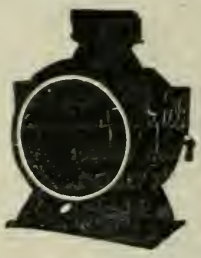

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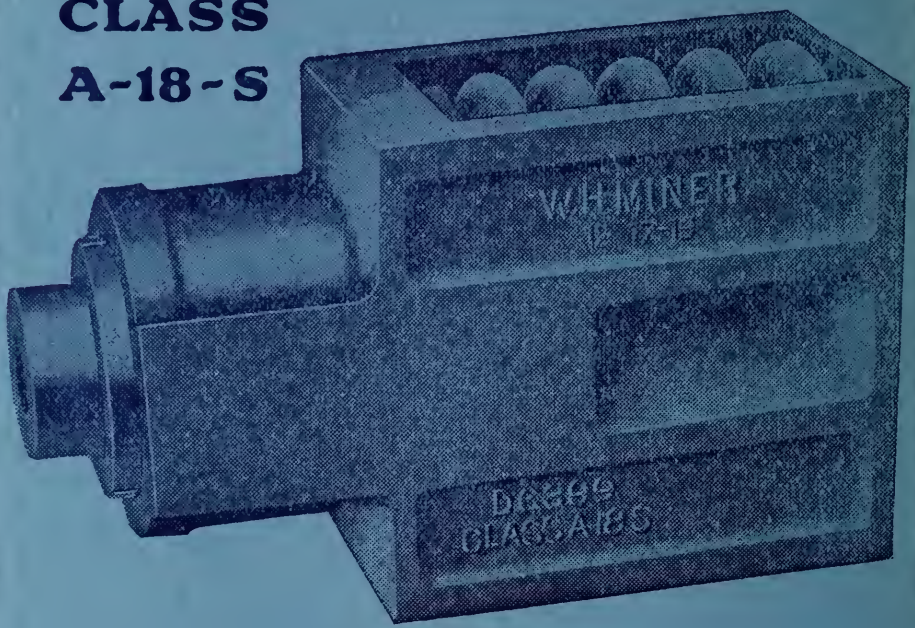

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